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Time for Improvement: Nonroutine Problem Solving and the Time Management Problem in Organizations

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Abstract

This paper describes time-related difficulties in undertaking non-routine problem solving activities in technical organizations. Using data drawn from longitudinal studies in two organizations, we examine this issue from two angles: first, what is the effect of nonroutine problem solving activities on time management in the rest of the organization, and, second, what is the effect of temporal issues at the organizational level on groups who undertake nonroutine problem solving? We find that nonroutine technical problem solving does affect time management at the organization level, because it generates unpredictable interruptions throughout the organization. Furthermore, interruptions become part of a larger cycle of "wait time" and delay that can jeopardize other local problem solving efforts. Specifically, when key people or resources needed for the problem solving effort are not available in a timely manner (due to prior interruptions or other reasons), problem solving becomes more costly and more difficult to complete. Thus, we suggest that the need for nonroutine technical problem solving introduces important time management issues into organizations. We argue that these issues have not been recognized or mapped adequately in the literature on technical problem solving, and we outline some methodological requirements of further work in this area.

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In the last few years, it has become clear that organizations which cannot improve their products and processes on an ongoing basis will increasingly be at a competitive disadvantage (e.g., Imai, 1986). At the same time, research has revealed some of the difficulties of stepping outside of normal activities to undertake such improvement. In particular, research from psychological, organizational, and economic perspectives shows that the routines and assumptions associated with everyday activities can represent a formidable barrier to nonroutine problem solving (e.g., Langer, 1983; Louis and Sutton, 1991; Nelson and Winter, 1992). According to this view, nonroutine problem solving is difficult because it calls for fundamentally different modes of thinking than do regular operations (March and Simon, 1958; Hedberg, 1981).

In this paper, we investigate an additional reason why nonroutine problem solving is difficult to undertake and to complete. We suggest that such problem solving activities introduce serious time management difficulties into the organization. Our argument has three parts. First, we find that time management problems at the organizational level directly affect the progress of problem solving efforts at the project level. Specifically, we find that problem solving efforts are often stalled while participants wait for experts or other resources that cannot respond promptly to requests for input. These waiting times, in turn, impose large costs on problem solving efforts, and are a major reason why organization members abandon problems before resolving them. Second, we also find that nonroutine problem solving exacerbates the time management problem for organizations, because these activities generate a large number of unanticipated and often time-consuming interruptions. That is, in order to gather the information and resources they need, problem solvers often

interrupt people working on a wide variety of other tasks throughout the organization. At a local level this speeds specific problem solving efforts, however at the organizational level it represents significant disruption to the firm's work flow.

Finally, we hypothesize that, in many cases, the severity of waiting times is related to the level of interruptions generated by problem solvers in other parts of the organization. That is, it appears that the interruptions generated by problem solvers at one point in time may be one reason why experts are unavailable to respond quickly to new problems as they develop. This suggests that, unless the cycle of interruption and unavailability is carefully managed, nonroutine problem solving efforts will have a self-limiting effect in organizational settings.

Background

By definition, nonroutine problem solving is difficult because it involves responding in a timely way to unplanned events, such as machine breakdowns, new customer requests, unforeseen technical interactions, or newly-recognized opportunities for improving routine operations. Much of the existing research on the difficulty of undertaking nonroutine problem solving in organizational settings focuses on the perceptual problem of noticing unexpected problem stimuli in the first place. Given that organization actors have limited perceptual resources, they are often so involved in everyday routines that they fail to notice signals indicating that those routines need adjustment or repair (March and Simon, 1958). Moreover, the mental scripts and schemas that guide actors' attention during everyday activities often do not incorporate problem scanning and problem recognition routines, thus making it less likely that problems will

be noticed and dealt with (Kiesler and Sproull, 1982). Cognitive limitations also pose barriers to effective problem solving. Even when problem signals are noted, they are often perceived as nonproblematic because they are interpreted within existing, static mental frameworks (Hedberg, 1981; Argyris and Schon, 1970). As Louis and Sutton (1991) argue, organizational problem solving is difficult because it requires "switching cognitive gears" from "habits of mind" to active thinking. Finally, there are affective reasons why problem solving is often difficult or neglected in organizations. Signals of problems can fail to trigger active problem solving because organizational actors are unwilling to admit to themselves or to others (e.g. managers with funding authority) that problems exist and must be dealt with (Kiesler and Sproull, 1982; Van de Ven and Polley, 1992).

Although such perceptual, cognitive and affective explanations are important, they are limited because they focus on individual-level factors and they provide mainly static explanations. Thus, they fail to take into account the fact that problem solving in organizations is sequential through time and is affected by the dynamic flow of events at individual, group, and organizational levels. Some researchers have therefore suggested that technical problem solving in organizations should be studied over time (Van de Ven and Rogers, 1988; Van de Ven and Polley, 1992) and accompanying theoretical explanations posed within a temporal context (Pettigrew, 1990).

Some researchers have begun to examine time management and temporal pacing in organizations to explain both the difficulty of active problem solving, and its occasional occurrence. some of this work examines the power of beginnings for enabling problem solving. Because organizational routines and mental schemas develop over time, active problem solving is most likely at the start of a new project or activity

(Weick, 1990; Tyre and Orlikowski, 1994). Once such routines are developed, intense time pressure to complete projects or to produce results can make it especially difficult to find time for nonroutine problem solving (Cangelosi and Dill, 1965; Van de Ven and Polley, 1992). On the other hand, some time pressure can be helpful for promoting problem solving; milestone dates and deadlines serve as "organizational alarm clocks" for adaptive problem solving, by reminding members that if progress is not on track, change from existing routines may be necessary (Gersick, 1988; Hackman, 1990). An interruption of the normal temporal flow of events can also help to turn attention away from routine execution and toward problem solving. In particular, surprising or disruptive events can help to jolt organizational actors out of normal routines and to make clear the need for active problem solving (Weick, 1990; Louis and Sutton, 1991; Tyre and Orlikowski, 1993). Disruptive events can provide the "pause in the action that is necessary in order to allow an organization to change from execution of action programs to genuine problem solving" (Hedberg, 1981). As Dutton (1993: 201) points out, unexpected or disruptive events (whether they are framed as threats or as opportunities,) often lead to active problem solving because they "serve as punctuating points that ... transform an individual's and a collectivity's time frame from current to future."

However, existing research has not examined how nonroutine problem solving activities affect time management and temporal pacing on an organization level. Nor have scholars examined how time management at the organization level affects members' ability to carry out problem solving activities (except to say that time pressure may be an important variable).

In this paper, we examine interdependencies between problem solving activities at the local, project level, and time availability at the level

of the organization or system. Drawing on data from projects in software development and manufacturing settings, we first address two empirical questions: (1) How do temporal issues at the organization level affect members' ability to carry out nonroutine problem solving in response to difficulties at the local, project level? (2) How do local, nonroutine problem solving efforts affect the nature of time and time pressures in the rest of the firm? Next, we propose a means of integrating these results into a dynamic model that partially accounts for the difficulty of nonroutine problem solving in organizations. Specifically, we suggest that local problem solving activities create a series of hard-to-manage interruptions that propagate through the organizational system. These system-level disruptions, in turn, can translate into stalled problem solving efforts, because people and other resources are not readily available to help with these activities.

We suggest that our findings have important implications for process research on the management of technology and technical problem solving. While previous researchers have suggested that the "variables involved in innovations [must] be sequenced and analyzed through time" (Van de Ven and Rogers, 1988), we find that it is also important to examine the nature of the time available in organizations, and how the variables of interest might affect (or be affected by) that quality.

Methods

This paper is the result of two separate but related studies undertaken by our research group. Both studies were longitudinal, and both examined the relationship between normal operations and nonroutine problem solving over time. The first study attempted to identify how time

and time management issues at the organization level affected the ability of project groups to carry out nonroutine problem solving. This required following specific projects and the problems they encountered over periods ranging from two months to two years. The second study was designed to capture the temporal effects of local, nonroutine problem solving activities on the larger organization. Examination of this question required understanding exactly how people involved in nonroutine problem solving spent their time, and how that affected the nature of time and time management in other parts of the organization. Thus, this study focused on individual problem solvers, and observed their activities in detail over the course of several days.

These two studies were undertaken in very different environments: the first study examined nonroutine problem solving around newly implemented manufacturing technologies, whereas the second study examined nonroutine problem solving in software development projects. At the start of our research, these two studies were envisioned as separate efforts. However, as we began to compare our results, we recognized that potentially important new insights sprung from juxtaposing findings from two different environments. Thus, we decided to integrate our results in order to develop new theory for understanding the temporal issues involved in nonroutine technical problem solving in organizations. Beyond the opportunity to build new theory, this strategy offers several advantages: It helps us to bridge the traditional gap separating research in hardware and software settings, and it enables us to discuss generalizability beyond the boundaries of a given industry or type of technical project. At the same time, however, we recognize that the conclusions from this effort

will need to be corroborated by multi-level studies in more controlled organizational settings.

The first study examined the question, how do issues of organizational time management affect the ability to undertake nonroutine problem solving at the project level? The study was undertaken at Ditto, Inc. (a pseudonym), which is a manufacturer of office equipment such as copiers, data imaging equipment, etc. The research examined 16 projects involving the integration of new process technologies into manufacturing activities in 5 separate factories.

Locating this study in a manufacturing environment was useful because, as shown in previous research, project participants often feel such high pressure to maintain routine production that it is difficult for them to undertake nonroutine problem solving (Tyre and Orlikowski, 1994). Thus, we knew that time management issues would be involved, however interactions between the project and the organization level have not been clarified in previous research.

The research was longitudinal, following projects from initial implementation of the new technology until the project was considered "complete" (the technology was running smoothly and responsibility was transferred to manufacturing). During that time, project participants were interviewed monthly. Respondents included at least one user (the prospective "owner" of the technology) and one developer. Interviews were used to identify and track all of the technical problems encountered in the project. At each monthly interview, project participants were asked to elaborate on the progress made in resolving each outstanding problem (or, if no progress had been made, to explain why). In particular, we noted all

comments relating to the factors that posed significant barriers to ongoing problem solving efforts (or, attributions for the failure of problem solving efforts, when that occurred).

In total, participants across all projects identified a total of 85 problems. Of these, 63 were resolved (in some way that was rated as satisfactory or better by participants), and 22 (or 26%) were not resolved (i.e., they were abandoned before a satisfactory solution was achieved). Since these problems were not catastrophic, this meant that faults or inefficiencies and were tolerated on an ongoing basis.

To investigate the question of how problem solving is related to the level of interruptions, the second study observed the daily behavior of six software developers at Telecom, Inc. (a pseudonym), a large U.S. telecommunications company. The subjects for this study develop software for a real-time switching system. Developers are responsible both for creating new hardware and software features for the system, and for on-going system maintenance. The latter includes nonroutine problem solving related to technical breakdowns or "bugs" and new customer requests for modifications. Two previous independent surveys at Telecom had specifically cited "interruptions" as one of the primary impediments to individual productivity (Baumann, 1990; Kelly and Caplan, 1993). We were interested in the extent and nature of such interruptions, as well as their implications for time management.

Each software developer was observed for 5 days at random over the course of a two month period, yielding 30 days of total observation. Besides recording the length and nature of each subject's principle daily activities, we monitored the in-person visits, phone calls and electronic mail that

developers initiated and received over the course of each observed working day. The result was an impressive set of micro level detail on what software developers actually do with their time (Perry, Staudenmayer and Votta, 1994).

Appendix A shows an example of the raw data collected on one subject, indicating the level of granularity of the observations (often down to three minute intervals). Thus, although the number of subjects was small, the number of (problem solving and other work related) activities was quite large, lending greater empirical support to our propositions. In addition, subsequent benchmarking within the organization indicated that these six developers and their daily behavior were representative of the larger population of software developers.

Results

I. Effect of the organization's time flow on problem solving efforts: The negative effect of "wait times".

In this analysis, we focus on problem solving failures at Ditto -- that is, problems that were abandoned without being resolved -- and seek to identify reasons for this failure. In each of these cases, problem histories were coded to determine the reasons why problem solving was not carried out to its conclusion. Interestingly, in no instance did respondents indicate that the issues involved were technically intractable. Rather, respondents' problem histories indicated that they faced four major barriers to problem solving. (See Table 1.) First, problem solving efforts were often interrupted by significant time lags in the problem solving process. That is, problem solving progress was delayed because project participants were forced to wait for long periods for inputs such as experts' time, test results, or other

necessary resources. These time lags led to frustration and increased the cost and difficulty of problem solving. Second, project participants found that time to do problem solving was often squeezed out by time pressures associated with regular production. Third, problem solving was often made difficult or impossible by turnover among project participants, and therefore loss of knowledge and momentum in problem solving efforts. Fourth, problem solving efforts were sometimes abandoned because project participants could not get sufficiently detailed or consistent information regarding customers' technical requirements, as needed to identify problems and measure solutions.

Table 1
Barriers to Successful Problem Solving
With New Process Technologies

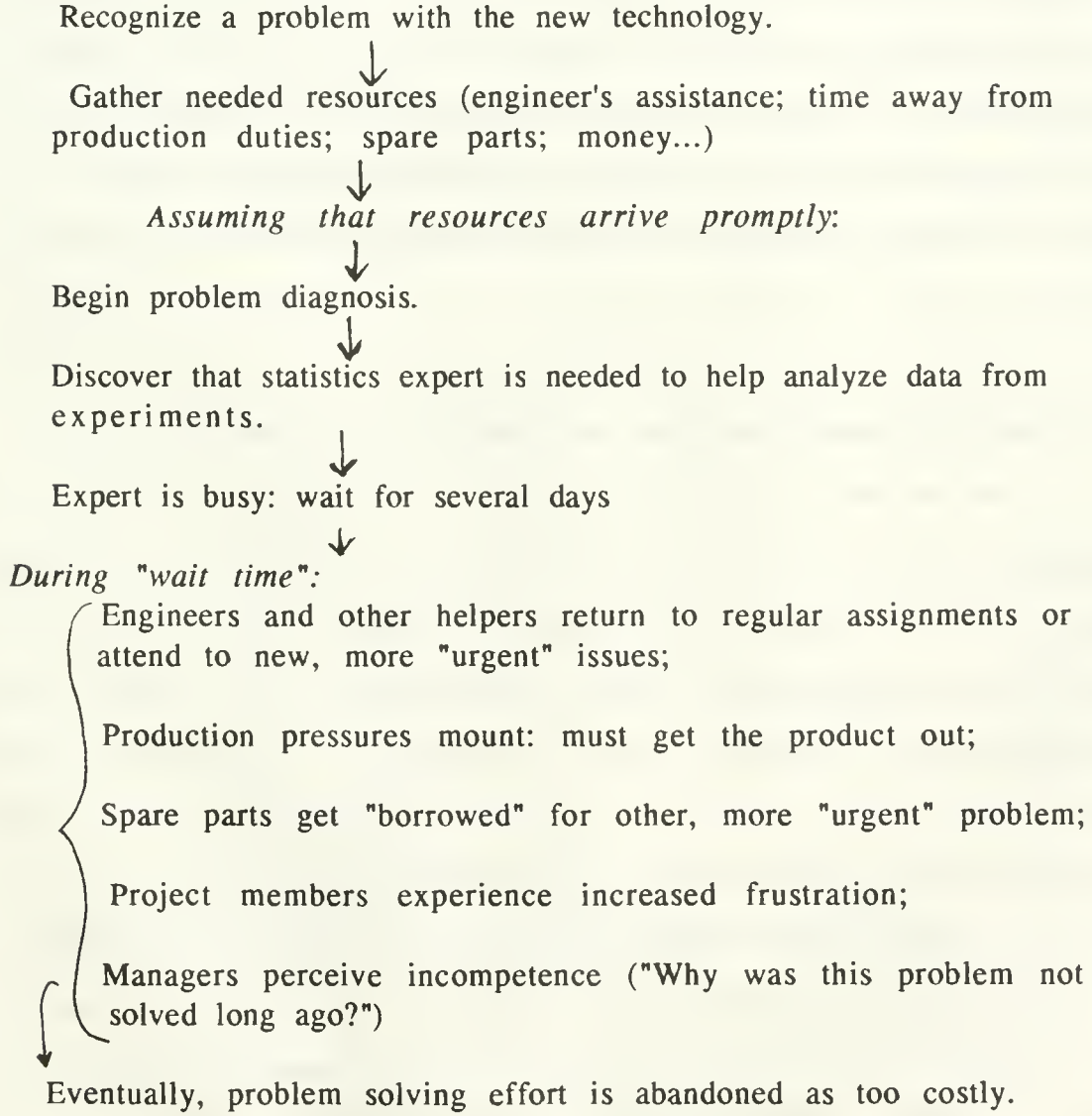
	% of failed efforts where this factor was judged critical[1]
Time lags in the problem solving process	73%
Production pressures leave no time for nonroutine work	64%
Turnover among project personnel	50%
Insufficient or inconsistent information re. customer needs	37%

As seen in Table 1, the most commonly-cited reason for abandoning problem solving efforts was the difficulty associated with time lags in the problem solving process. During interviews, respondents talked at length about the negative effects of such time lags. Further, because this research

[1] Note that a single failure can have multiple contributing factors.

was longitudinal, we were able to track what happened to problem solving efforts following significant delays at any stage. Comments and observations regarding the effects of time lags are summarized in Figure 1. As shown, when problem solving was forced to wait because experts or other resources were not available, this not only slowed problem solving, but also raised costs and frustration -- ultimately (in many cases) to the point where the effort was abandoned.

Figure 1
Anatomy of a Problem Solving Effort with "Wait Time"



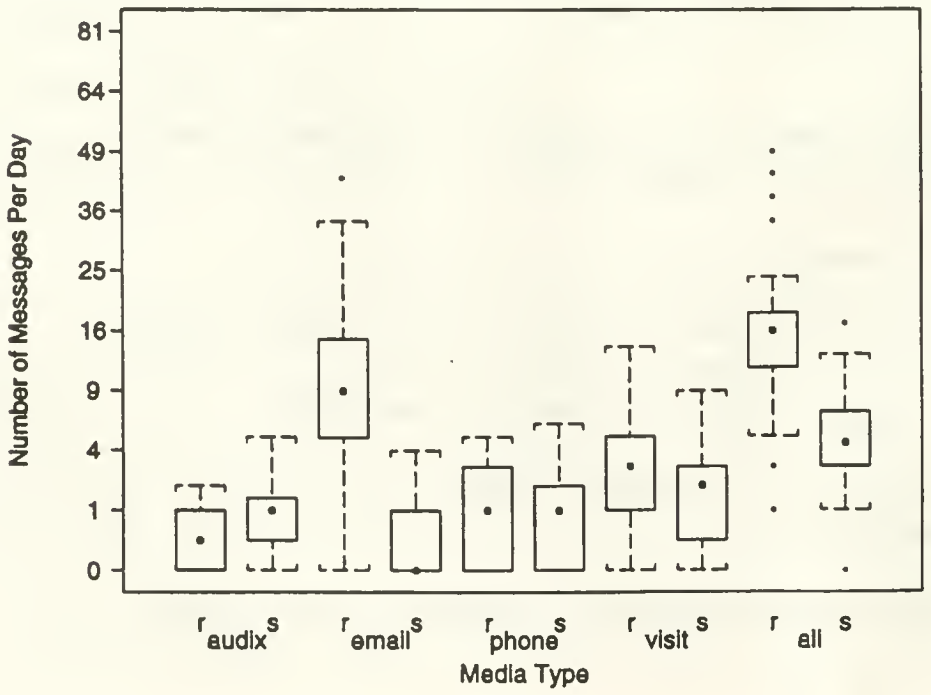
2. One effect of non-routine technical problem solving: The generation of interruptions

Drawing on the raw observational data at Telecom, we extracted all instances of unscheduled interaction across four major media channels (in person visits, phone, voice mail and electronic mail). (Appendix B presents a sample of the summary sheet we prepared on each subject; the table entries contain the total number of unique daily contacts as well as the duration and time of day of a particular exchange.)

We found that a large amount of a developer's working time was occupied by short, unplanned interactions. Figure 2 presents a boxplot diagram depicting the number of interruptions the subjects sent and received across the different media channels. Each box contains data on all six study subjects across five days of observation per individual. The upper and lower ends of the boxes represent the upper and lower

Figure 2

Number of Interruptions Sent and Received Per Day



The data are plotted using a square root transformation

quartiles; the bold point within each box is the data median. The detached points are outliers lying beyond 1.5 times the interquartile range. As indicated in the far right box of Figure 2, during a typical working day subjects received a total of 16 interruptions and initiated a total of 6 interruptions. These interruptions were typically brief (68% took less than 5 minutes) but widely distributed (a median of 7 colleagues were contacted per day).

Compared to this typical interruption pattern (represented by the medians in Figure 2), the outliers are particularly significant. When an individual (a developer or someone else in the organization) experiences a particularly frequent or especially long unplanned interactions, his or her ability to schedule time, to perform routine functions, or to respond to new issues virtually disappeared. And, significantly, all of the outlier observations (in the sense of frequency, duration and number of unique contacts) were associated with unplanned, nonroutine problem solving activities, not with routine feature development work. The specific form of nonroutine problem solving observed as termed a "modification request" (or MR). These were usually motivated by customer reports of an unanticipated problem with the technology in the field. Upon receiving an MR, a developer was required to identify and analyze the source of the observed error in call handling and make the necessary changes to the existing software base to rectify the error. This took precedence over current new development work.

Some MRs were relatively simple and could be accomplished quickly and locally. However, on five[2] of the 16 days when we observed a developer working on an MR, the number of unique contacts (see Figure 2),

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[2] These five "outlier" days represent approximately 16% of all days of observation.

as well as the frequency and duration of interruptions rose dramatically. In the most extreme cases, the number of unique colleagues contacted during the day rose to 17 (compared to 7 on a normal day), the number of interruptions initiated and received was 45 (vs. 16) and the duration of the exchange was over one hour (vs. several minutes). Most of these contacts were requests to change code owned by another developer, requests for passwords, searches for information or documentation, and exchanges of advice with peers and experts. Of particular relevance for our thesis, interruptions related to nonroutine problem solving were not limited to a developer's immediate working group, but involved key personnel throughout the organization. On MR days, the median number of people contacted was 10 (compared to 7 on days of routine work), while the most difficult MRs triggered 15 to 17 contacts throughout the day. These results illustrate the ripple effect that nonroutine problem technical solving can generate beyond the immediate project.

Discussion

The two results described above merit attention both separately, and for what they suggest when considered together. While other research has analyzed problem solving as an interruption of ongoing work at the local level, this paper highlights the ways in which problem solving activities can create (or can reflect) a series of hard-to-manage interruptions throughout the organizational system. Thus, in both cases, our results suggest interdependencies between time management at the level of the organization and project-level problem solving that are not recognized in the literature.

First, we found that while the pressures of everyday production do indeed make it difficult for personnel in manufacturing projects to find time for nonroutine problem solving around new technologies, the relationship is more complex than is often recognized. In particular, normal time pressures are exacerbated by "wait times" inserted into the problem solving process whenever experts or other critical resources are not available in a timely manner. These wait times lead to other difficulties (problem solving teams disperse, resources dry up, management pressure mounts) that often force problem solvers to abandon their efforts. This suggest that the more promptly the organization can release experts and other resources needed for local problem solving efforts, the more likely these efforts are to be completed.

Second, we found that even in the domain of software programming, which is widely regarded as an individual or small group activity, nonroutine problem solving at the project level affects time management at the organizational level. Specifically, on days when the software programmers in our study had to attend to non-routine problem solving, they often received *and* initiated an unusually large number of interruptions compared to days of routine (development) work[3]. On problem solving days, programmers were also required to interact with a wider universe of peers and colleagues. Further, problem-related interruptions frequently led to much longer unplanned interactions than was usually the case. Thus, while interruptions helped problem solvers to access expertise and information which were distributed throughout the organization, they also disrupted people and work flows just as widely.

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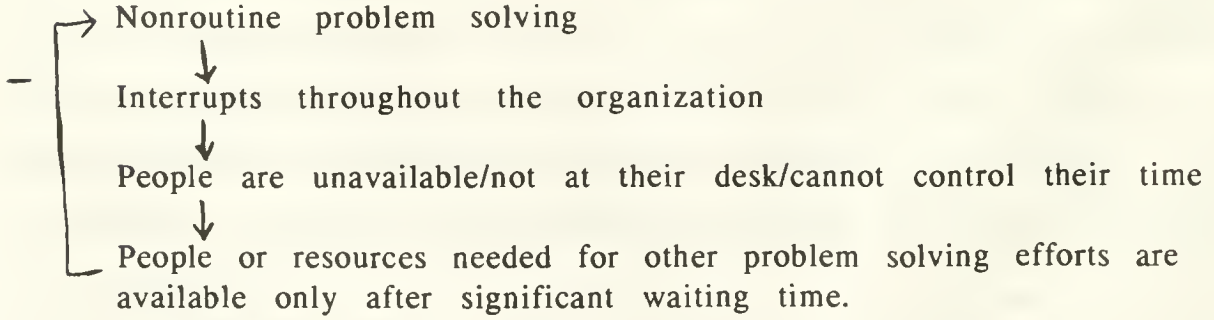
[3] Note that the interruptions "received" were often call-backs from people who had been contacted earlier but who had been unavailable. Thus, the number of initiated interruptions reported here is a conservative estimate.

When considered together, these two sets of results raise interesting questions, and allow some partial answers. In particular, while our first study indicates that wait time is an important barrier to problem solving, it does not explain w h y delays were commonly experienced. Our second study helps to answer this question. Specifically, we hypothesize that there may be a relationship between the interruptions initiated by problem solvers in one project, and the wait times experienced by problem solvers somewhere else. This is because such interruptions not only disrupt the normal flow of work in various parts of the organization, but also serve to pull experts (and other resources) out of circulation at unscheduled intervals and for highly variable (and unpredictable) stretches of time. Thus, it is possible that even in an organization that is properly staffed *in aggregate* with experts and other resources, these may not be quickly available to respond to a given problem, due to the disruption caused by earlier problem solving efforts. This suggests that, in organizations where nonroutine problem solving is a significant requirement, there could be a tendency for such activities to be partially self-limiting, as described in Figure 3:

Figure 3
The self-limiting nature of non-routine problem solving in organizations.



These relationships among nonroutine problem solving and organizational time management are supported and clarified by anecdotal evidence from our studies. In particular, comments by some of the respondents in the software study make it plain why even a relatively modest level of interruption can seriously disrupt experts' ability to respond quickly to new problems. First, interruptions are not evenly distributed throughout an organization. Instead, problem solvers most often turn for help to those who are highly experienced, knowledgeable, *and* who are viewed as approachable by colleagues. Like technical "gatekeepers" (Allen, 1977), such key individuals are likely to emerge informally, and thus their time is not likely to be consciously managed as a critical technical resource. Thus, certain individuals may be responsible for a disproportionate number and length of the "wait times" that plague problem solving efforts throughout the organization; they become a critical problem solving bottleneck. At Telecom, for example, one developer clearly received a disproportionate share of requests for help. As he described it, "I am 'Mr. Interrupt'" Similarly, at Ditto, many of the wait times documented could be traced to a single statistical expert who was *de facto* supporting several nearby factories, but whose time as a critical problem solving resource was not consciously managed.

For these key experts, the difficulties of scheduling and setting priorities were compounded by the fact that problem-driven interruptions are urgent (or are perceived that way), and demand immediate attention. As one of the software experts we interviewed stated, when a request comes to help with a modification, "you live the modification," because field problems demand priority over other ongoing activities. According to another highly sought-after expert at Ditto, "I try to be available; that's part

of my job. But sometimes I am so busy being available that I can't get anything done." This situation means that problem solving bottlenecks can spiral, with experts too busy to complete one problem solving effort or to respond quickly to the next one. This also supports our proposition that stalled problem solving efforts tend to lose resources very quickly to new, more currently pressing issues.

Similar cycles of disruption have been found in other studies as well. For example, in Perlow's (1995) study of product development teams, she found that because developers were frequently interrupted for help on nonroutine issues, they operated in a perpetual "crisis mode" (involving rush schedules, overtime work, etc.). This situation not only made it difficult to get their normal work done during business hours, but also made developers difficult to find whenever colleagues needed their help on unusual problems.

Conclusions

In this paper, we have suggested that nonroutine problem solving at the project level can seriously disrupt people and their work flows throughout the organization -- and that such disruptions, in turn, can create an important barrier to effective problem solving in other parts of the organization. This suggests that, beyond any costs that they impose within a given project, interruptions can have important system-wide effects; they can actually begin to drive the organization, as people respond to issues as signalled by interruptions, not according to business or technical priorities.

While this analysis has focused on the negative impacts of interruptions, it does not necessary follow that organizations should strive

to eliminate such unplanned interactions. Indeed, interruptions are often useful and even necessary to organization functioning. Clearly, the ability to interrupt a colleague for help has important, local advantages for technical problem solving in organizations (e.g., Pentland, 1992). Nor are interruptions always dysfunctional for the organization as a whole. Such "short, disjointed interactions" are often efficient insofar as they save time (obviating the need to plan and schedule a more formal meeting) and enable work to progress despite minor obstacles (Kotter, 1989).

Further, the spontaneous, unstructured exchange of ideas is a vital part of the creative research process (Allen, 1977). Subtle prods, nags and questions can also help sustain work progress and flag minor problems early on (Kraut and Galegher, 1990). The temporal nature of interruptions (the fact that they break up routine, scheduled time) can also be important for raising arousal and interest levels (Weick, 1990).

Unplanned interruptions are also an important component in the development and maintenance of peer and working relationships. For example, Festinger, Schacter and Back (1950) noted that "brief encounters made as one goes about one's normal business" are an important determinant of friendship formation. Others have likewise suggested that mutual expectations and trust are often worked out over time during a succession of "ad hoc encounters" (Gabarro, 1978). Further, classic studies on organizations as well as more recent ones have shown that problem-related interruptions are an important mechanism for organizational learning and even organizational structuring (Blau, 1955; Pentland, 1992).

On the other hand, it seems clear that interruptions need further attention if they are not to disrupt both routine operations *and* further problem solving efforts in the rest of the organization. In many

gets interrupted, and when, depends on random events and on tacit, largely unchallengeable social conventions (Pentland, 1992). There is little or no explicit planning or management of this process. Our findings suggest that this may not be optimal. Informal social rules tend to ensure that a small number of experts (those who are both knowledgeable and approachable) get a disproportionate share of interruptions. Unless the time of these key people is carefully managed, they can become a critical bottleneck in the organization's ability to attack and resolve new problems.

A very small number of organizations has begun to experiment with ways of managing interruptions. In particular, one company in Japan and one in the U.S. have announced that, in an effort to protect technical workers from constant interruptions, unplanned interactions are prohibited during certain blocks of time every day (Miller, 1994; Perlow, 1995). A different approach would involve identifying key experts within the organization who are most often called on to help with nonroutine problem solving, and enabling them to schedule their time more effectively. For example, one could designate some fraction of their time to be "on call (similar to what is done in teaching hospitals), rather than asking them to carry a full schedule of project work and administrative tasks. "On call" experts would need to have full information about local projects and organizational priorities to choose among urgent requests. Also, "on call" experts would need to be recognized and rewarded for their role in providing help on unplanned, nonroutine activities.

Beyond these practical considerations, our research also has interesting theoretical and methodological implications relating to the study of temporal and interpersonal issues in technology management. First, given the dynamic nature of the issues involved, we note that technical

problem solving in organizations must be studied over time. Further, in order to capture these dynamic interactions, longitudinal studies need to examine multiple levels of analysis (individual/group/organizational) simultaneously. Moreover, our research suggests that we must go beyond examining problem solving over time, to enter time as a variable in our consideration of problem solving and other activities in technical organizations.

At a theoretical level, our study of problem solving-driven interruptions suggests that we may be paying too much attention to the obvious, formal activities in technical organizations (such as product development projects, product launches, etc.), and not enough to the unsanctioned but very real informal actions and interactions that support the organization's functioning. Besides problem-driven interruptions, these include product and project expediting, crisis (and mini-crisis) management, fielding questions from customers, etc. Similarly, current research agendas tend to emphasize the orderly flow of events over time, and to neglect the chaotic component of time management in organizations. In fact, many technical people in organizations strive heroically to juggle unpredictable and seemingly incompatible time demands. Our work suggests that we need better and more dynamic theories of time in technology management to help support their efforts.

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Appendix A

Raw Observational Data on One Software Developer

Subject: 2C

Date: 930629

0830: IN

0833: Read Email

7 new messages (3 process change alerts, 2 executive project reports, 1 MITS reminder, 1 celebration notice)

0836: Receives phone call from lab; requesting a build product to test new circuit board

0900: Group meeting

1022: Receives visit

Visitor needs algorithm to test RAM on new hardware

1025: Makes phone call to lab; still working on build product requested earlier

1026: Works on build product

1032: Break

1035: Works on build product

Appendix B

Communication Summary Sheet Example

SUBJECT IN

	VOICE MAIL		EMAIL		PHONE		VISIT	
	Initiated	Received	Initiated	Received	Initiated	Received	Initiated	Received
Day 1								
Day 2								
Day 3								
Day 4								
Day 5								

Date Due

SEP. 8 1995

DEC. 3 1 1995

NOV. 2 5 1997

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